

## LAB ACTIVITY: A BALANCED TANGLE



**OBJECTIVES:** Students will:

- + Understand the nature of a system
- + Be able to identify key concepts of systems,
- + Design, assemble, analyze, and troubleshoot a simple mechanical system;

**MATERIALS:**

- + Pictures of different kinds of "systems;"
- + **Student Sheets**
- + For each 2-3 students:
  - 12 8-penny nails with flat heads (not finishing nails)
  - 1 larger nail
  - 1 piece of scrap wood about 6 cm square OR a lump of clay which could hold the large nail in place;



**PROCEDURE:**

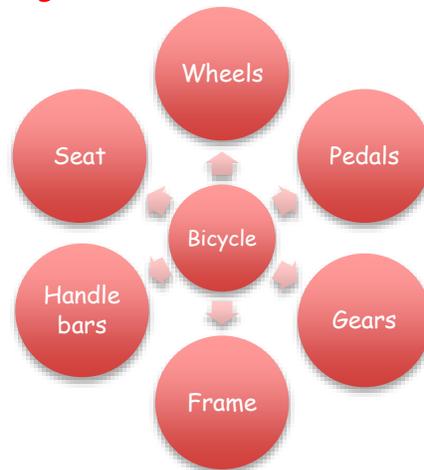
### **PART A: What is a "system?"**

1. The first goal of this lesson is to get students to agree on a common definition of the term, "system."
  - + Direct the question "When you hear the word, "system," what words or images come to mind?"
  - + Accept and record all responses. If students didn't mention a bicycle as an example of a system, ask them if they think a bicycle is a system, and why. (NOTE: If possible, have a bicycle in the classroom for students to view/manipulate.)

## Teacher Sheet 2

- ✚ Guide students to the understanding that the bicycle is a system, made up of many parts. (Note: Create a graphic organizer on the board to identify all the parts and their roles.)

### Sample graphic organizer:



- ✚ Considering the bicycle, as well as other examples of systems you came up with help students to create a general definition/understanding of a system. (NOTE: Possible responses could include: a system is made up of different parts that come together to form a whole; a system is a collection of things and processes that interact to perform some function.)

2. Students should already know that if something consists of many parts, the parts usually influence one another. Also they should be aware that something may not work as well (or at all) if a part of it is missing, broken, worn out, mismatched, or misconnected. Students should be able to identify the properties of the various parts or *subsystems* of a bicycle and examine how they relate to the whole.

- ✚ Lead a discussion to help students begin to understand how every part of this system relates to the others.

Ask questions such as:

- ✓ What if one part of the system weren't there?
- ✓ How would this affect the system?
- ✓ What does each part do?

### Teacher Sheet 3

- ✓ Describe some of the features of these parts.
- ✓ What is the purpose of a bicycle system?
- ✓ What parts of the bicycle must work together if you want to ride around a corner? (*Wheels, frame, steering, and human power all work together to ride the bicycle around a corner.*)
  - ✓ How is the bicycle system related to other larger systems? (*It can be related to road, air currents, and weather systems.*)
  - ✓ The seat is one part of the bicycle. Use three different words that describe the seat. Do any of these words also describe the whole bicycle? (**Possible answers include: soft, hard, smooth, narrow, uncomfortable. These could also describe the bicycle as a whole.**)
  - ✓ How would the functioning of the bicycle change if one part or **subsystem** wears out? (**The bicycle would be more difficult or impossible to ride.**)

3. Students should demonstrate an understanding that all the (parts) need to work together for the bicycle to function. Once you feel confident that they have achieved the necessary level of understanding continue to hands on part of the activity **"BALANCING NAILS."**

### PART B: BALANCING NAILS

1. Pass out the materials to each group of 2-3 students.
2. It's possible to have 5-7 people working on one **BALANCING NAILS** activity but it works better with smaller groups
3. Post the following in the front of the room or make copies for each group.

#### BALANCING NAILS

**STEP 1:** Arrange the remaining 12 nails so that they are all balanced on the head of the large, stationary nail. Several different configurations are possible and you may definitely have a very different solution than your neighbors. Only discuss it with your partner (s).

**STEP 2:** Once you have successfully balanced the nail system, do the following:

- Record your system with a drawing and a written description.
- Share your design with the rest of the class.
- Answer the **ANALYSIS** questions.

## Teacher Sheet 4

4. Go over the instructions with the class. Be sure students know to only share ideas of information with their partner.
5. Only the supplied equipment can be used (no tape, string, glue, etc. allowed). The supplied materials may not be altered.
6. The nail hammered into the piece of wood must lay flat on a surface with the wood on the surface and the head of the nail facing upward (as shown in picture).
7. The supplied "free" nails may only touch the nail hammered into the wood and nothing else.
8. You may also wish to impose a time limit of a prize for the team who solves the challenge in the quickest time.
9. There are a number of solutions to this problem:
  - ✚ The easiest is to start by balancing one nail sideways across the head of the upright nail.
  - ✚ Once this is done, the other nails can be hung on this horizontal nail in alternating directions.
  - ✚ The most important aspect is to ensure the center of gravity stays over the head of the upright nail.

### EXTENSION:

- ✚ What is the maximum number of nails you can balance in this way?
- ✚ Try making a second row and balance it on top of the first. How many layers can you balance in total and how many nails does this use?
- ✚ Can anyone find a different way of balancing the nails?
- ✚ Can you scale up this activity, for example using hockey sticks instead of nails?
- ✚ Can you scale down this activity using pins? (This is much harder; again, watch out for the sharp points.)
- ✚ Name and describe 3 natural systems?
- ✚ Name and describe 3 man-made systems?